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Subject: Additional Work in the Power Sources Area

Reference: Contract No. RD-107
Task No. 6
[redacted] Req'n. EH-78020 25X1

Dear Sir:

Pursuant to our discussions at your offices on March 23, 1958, we herewith submit a proposal to perform work which would lead to the delivery of a lead telluride Thermoelectric Generator. This work could be made an addition to Task No. 6, or issued as a new task.

Lead telluride offers several important advantages over the constantan metallic component used earlier in Task No. 6, among them being:

1. Stability at the required temperatures.

2. Ease of preparation.

3. Compatibility with bonding alloys.

This proposal is predicated upon receiving authority to proceed with the work described in the attached technical proposal, by May 5, 1958.

The total estimated selling price for this work, on a CPFF basis, is $76,240.25. Attachment "A" furnishes a breakdown of the selling price.

Should any further information be required, please call on me.

Very truly yours,

~~SECRET~~

[redacted] 25X1

Contract Administration

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FG/rmk
Attachments
CC: [redacted] 25X1

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CP/oe

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ATTACHMENT "A"

PRICE BREAKDOWN

ADDITIONAL WORK, POWER SOURCES

COST PLUS A FIXED FEE BASIS

| | | |
|---|---|---|
| **Material** | | |
| Dev. Material | | $ 800.00 |
| **Salaries & Wages** | | |
| Engineers | 120 M.W. | 23,361.00 |
| Draftsmen | 2 M.W. | 339.00 |
| Shop Labor | 6 M.W. | 827.00 |
| **Overhead** | | |
| Engineering | 165% | 40,470.00 |
| **Other Direct Charges** | | |
| Reports | | 800.00 |
| Sub Total | | $66,597.00 |
| G & A Expense | 6% | 3,995.82 |
| Total | | $70,592.82 |
| Fixed Fee | | 5,647.43 |
| SELLING PRICE | | $76,240.25 |

FG/rmk
4/15/58

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The tasks delineated under the present contract include the study and fabrication of thermocouple elements incorporating a p-type semiconductor and constantan. In addition, it calls for a prototype "frying pan" thermoelectric generator employing several of these elements in series. This portion of the study has been successfully completed and demonstrated to the sponsor.

Our experience in carrying out the work mentioned above indicates that the next problem to be solved is the study and substitution of a n-type semiconductor element for the constantan metallic component. In the present generator preliminary investigations indicate that lead telluride elements will have the greatest probability of success. The decision to use lead telluride is based not only upon its figure of merit, but also upon its stability at the temperatures involved (350°C), its relative ease of preparation, and its compatibility with bonding alloys which have been employed in development of the first thermoelctric generator.

It must be pointed out that in the development of this material we will expect to encounter some of the difficulties encountered with zinc antimonide under the current contract. Zinc antimonide, a p-type semiconductor, tends to remain p-type even in the presence of oxygen. On the other hand, n-type lead telluride in the presence of oxygen has a tendency to increase hole conductivity and therefore tends toward p-type conduction. The risk of encountering oxidation problems is somewhat diminished by the hermetic seal evolved for the model delivered under the present contract. In this device, Argon at low pressure surrounds the active elements of the generator.

Care must be taken in the formation and proper doping of lead telluride. Tellurium and lead of highest available purity will be allowed to react under controlled conditions of atmosphere, pressure and temperature, taking into account the incorporation of the proper amount of excess lead to assure n-type properties. It is hoped that as the result of this process, large single crystals of properly doped lead telluride will result.

The process of bonding lead telluride to the contact metal will be studied from the standpoint of producing mechanically strong bonds whose electrical and thermal resistances are low. The diffusion of such bonding material into the bulk of the lead telluride must not result in the diminution of the desirable electrical and thermal properties. From experience obtained to date, we can use the bonding agents which will give the best overall performance.

Since lead telluride has a different thermal conductivity than the constantan, a slight redesign of the thermocouple elements and the eventual "frying pan" may be necessary to optimize the efficiency. It is expected that the output of the finished device employing the same number of couples should be increased by a factor somewhere between 1.5 and 2.

To accomplish this task, we propose to utilize our best efforts in the following sequence:

1. Preparation of stoichiometric lead telluride from the purest available lead and tellurium.

2. Doping of the pure lead telluride with appropriate types and amounts of impurities.

3. Development of techniques for casting of mechanically stable ingots from which thermocouple elements can be prepared.

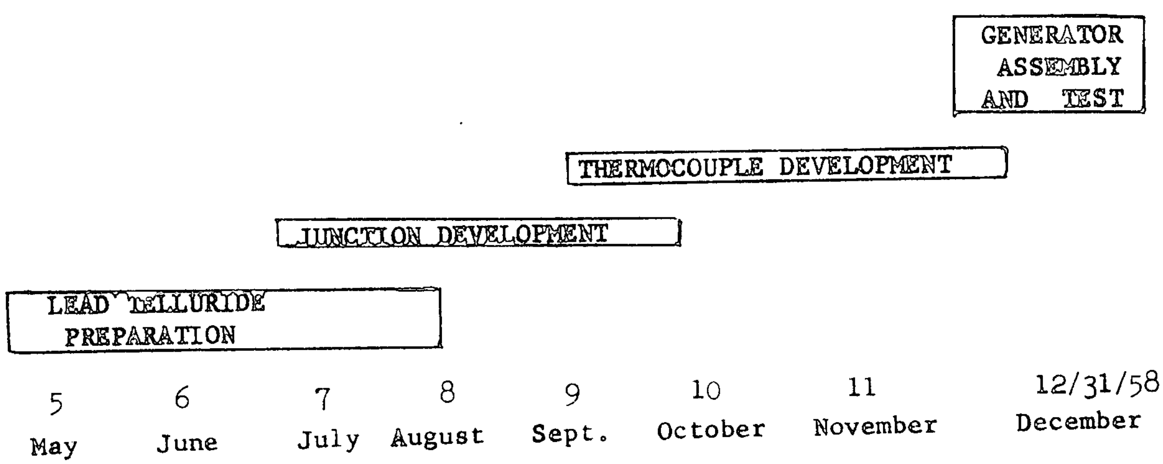
4. Investigations of bonding of conductors to lead telluride.

5. Concurrent with the above steps, make the appropriate electrical and thermal measurements including reproducibility of performance among samples.

6. Construct a "frying pan" generator with 20 couples.

7. Test for performance and stability as time permits.

We propose that this phase of the work would extend from approximately May 5, 1958 and continue until December 31, 1958. The following block diagram represents the expected flow of work during the period. The very nature of this project demands that there be overlap and feedback from one type of development with respect to the other.



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